

Attorney Docket No. 83085  
Customer No. 23523

ELASTOMERIC EJECTION SYSTEM WITH  
ACOUSTICALLY IMPROVED CHECK VALVE

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT WILLIAM P. BARKER, citizen of the United States of America, employee of the United States Government, and resident of Bristol, County of Bristol, State of Rhode Island, has invented certain new and useful improvements entitled as set forth above, of which the following is a specification.

MICHAEL P. STANLEY, ESQ.  
Reg. No. 47108  
Naval Undersea Warfare Center  
Division, Newport  
Newport, RI 02841-1708  
TEL: 401-832-4736  
FAX: 401-832-1231

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3 ELASTOMERIC EJECTION SYSTEM WITH  
4 ACOUSTICALLY IMPROVED CHECK VALVE

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6 STATEMENT OF GOVERNMENT INTEREST

7 The invention described herein may be manufactured and used  
8 by or for the Government of the United States of America for  
9 Governmental purposes without the payment of any royalties  
10 thereon or therefor.

11

## 12 BACKGROUND OF THE INVENTION

13 (1) Field of the Invention

14 The invention relates to elastomeric ejection systems for  
15 submarines, and is directed more particularly to such a system  
16 including an improved check valve affording substantially quieter  
17 operation than traditional check valves.

18 (2) Description of the Prior Art

19           Elastomeric ejection systems for submarines are generally  
20       known and are used to launch torpedoes and other weapons and  
21       vehicles, hereinafter referred to collectively as "bodies", from  
22       the torpedo tubes. Examples of such systems are illustrated and  
23       described in U.S. Patent No. 4,848,210, issued July 18, 1989 in  
24       the name of Laurent C. Bissonnette, in U.S. Patent No. 5,200,572,  
25       issued April 6, 1993, in the names of Laurent C. Bissonnette et

1 al, and in U.S. Patent No. 5,438,948, issued August 8, 1995, in  
2 the name of Paul E. Moody, all incorporated herein by reference.

3 In such systems the driving force for launching the bodies  
4 from the torpedo tubes is pressurized seawater, and the  
5 pressurization of the seawater is accomplished by storing a  
6 charge of seawater in an expandable elastomeric disk or  
7 structure. To charge the elastomeric disk or structure with  
8 seawater, a sea valve is provided in communication with a  
9 charging pump which is in communication with an inlet cylinder  
10 which, in turn, is in communication with the elastomeric disk or  
11 structure.

12 Between the charging pump and the inlet cylinder there is a  
13 check valve which, in a charging operation, allows seawater to  
14 flow from the pump to the inlet cylinder. However, once the  
15 elastomeric disk or structure is filled to capacity and the  
16 pressure in the elastomeric disk or structure and the inlet  
17 cylinder reaches launch pressure, the pump shuts down and a check  
18 valve shuts to prevent back-flow through the charging pump. The  
19 check valve typically makes a discernible noise upon closure.  
20 The noise can be detected by sensitive listening devices,  
21 permitting a target vessel a brief period of time in which to  
22 take evasive maneuvers in hopes of reducing the chances of a  
23 successful attack.

24 In U.S. Patent No. 6,443,182, issued September 3, 2002, in  
25 the name of Lance Hathcock, a non-slamming check valve is

1 disclosed. While the disclosed valve has a dampening effect on  
2 the wear produced by the valve closure, the noise of the valve is  
3 shifted from the closure to the dampening operation.

4 Specifically, a bleed hole (item 36 of the cited reference)  
5 in a dampening chamber (item 28) provides the pressure release of  
6 the dampening operation. The problem is that the passage area of  
7 the bleed hole is minimal in comparison to the remaining  
8 pressurized area of the valve (item 12). In a high-pressure  
9 environment, such as an elastomeric ejection system, a pressure  
10 release through the bleed hole may be loud, therefore not  
11 successfully accomplishing noise reduction. Furthermore, the  
12 comparatively minimal size of the bleed hole may inhibit the  
13 rapid closure response required by an elastomeric ejection system  
14 allowing the elastomer to deflate from its full volume  
15 effectively decreasing the energy available for launch.

16 Accordingly, there is a need for an elastomeric ejection  
17 system in which the check valve operates at a much lower sound  
18 level and in a rapid operation when the elastomeric disk or  
19 structure is made ready for launch.

20

## 21 SUMMARY OF THE INVENTION

22 An object of the invention is, therefore, to provide an  
23 improved elastomeric ejection system for submarines, the system  
24 featuring a substantially silent check valve, the operation of  
25 which is not readily detectable by other vessels.

1       With the above and other objects in view, a feature of the  
2 invention is the provision of an elastomeric ejection system for  
3 launching bodies from a submarine. The system comprises a pump  
4 for transferring seawater from outside the submarine to an  
5 elastomeric disk or structure and a check valve adapted to open  
6 to permit the pump to transfer the seawater to the elastomeric  
7 disk or structure, and adapted to rapidly close upon filling of  
8 the elastomeric disk or structure and expanding of the  
9 elastomeric disk or structure. The check valve is provided with  
10 a head and a seat portion, a stem portion having fixed thereon  
11 the head and a disk having a circular protrusion extending toward  
12 the valve seat portion, an annular cup stationarily mounted  
13 around the stem portion and having a circular depression in a  
14 surface thereof, the depression configured complementarily to the  
15 disk protrusion, and holes disposed in the cup and radially  
16 extending from the depression to an outer wall of the cup. In  
17 closure of the check valve, the disk circular protrusion enters  
18 the cup depression, forcing seawater in the depression to exit  
19 the cup through the flow restrictive paths comprised by the  
20 primary path of the decreasing annular gap between the disk  
21 protrusion and cup depression and the secondary path of the  
22 radial holes, to slow the valve stem portion, and thereby the  
23 valve head in movement into engagement with the valve seat  
24 portion.

1 The above and other features of the invention, including  
2 various novel details of construction and combinations of parts,  
3 will now be more particularly described with reference to the  
4 accompanying drawings and pointed out in the claims. It will be  
5 understood that the particular system embodying the invention is  
6 shown by way of illustration only and not as a limitation of the  
7 invention. The principles and features of this invention may be  
8 employed in various and numerous embodiments without departing  
9 from the scope of the invention.

10

11 BRIEF DESCRIPTION OF THE DRAWINGS

12 Reference is made to the accompanying drawings in which is  
13 shown an illustrative embodiment of the invention, from which its  
14 novel features and advantages will be apparent, wherein  
15 corresponding reference characters indicate corresponding parts  
16 throughout the several views of the drawings and wherein:

17 FIG. 1 is a diagrammatic view of an elastomeric ejection  
18 system for launching bodies from a submarine, illustrative of an  
19 embodiment of the invention;

20 FIG. 2 is similar to FIG. 1, but illustrating the ejection  
21 system ejecting a torpedo;

22 FIG. 3 is a sectional and perspective view of a check valve  
23 portion of the system of FIGS. 1 and 2, and illustrating a  
24 particular feature of the invention; and

1 FIG. 4 is an enlarged sectional and perspective view of a  
2 portion of the check valve of FIG. 3.  
3  
4  
5

6 DESCRIPTION OF THE PREFERRED EMBODIMENTS

7 Referring to FIG. 1, it will be seen that the illustrative  
8 system includes an ejection tank 10 defined in part by an  
9 elastomeric wall 12, which may be in the form of a disk. The  
10 ejection tank 10 is mounted outside of a submarine pressure hull  
11 14 and within an outer hull 16.

12 An inlet cylinder 18 is in communication with the ejection  
13 tank 10 at a forward end of the cylinder 18 and in communication  
14 with an impulse tank 20 at an after end of the cylinder.

15 The impulse tank 20 is disposed for communication with  
16 launch tubes 22a, 22b which house torpedoes 24, or other weapons  
17 or vehicles. Each launch tube is provided with a slide valve  
18 26a, 26b, respectively. When a slide valve opens, the launch  
19 tube affected thereby is placed in communication with the impulse  
20 tank 20.

21 A charging pump 28 is disposed for communication with a sea  
22 valve 30, which is exposed to seawater outboard of the submarine  
23 pressure hull, and for communication with the ejection tank 10,  
24 by way of the inlet cylinder 18, and the impulse tank 20.

1        Between the charging pump 28 and the impulse tank 20 there  
2    is disposed a check valve 36. In charging the ejection tank 10,  
3    the charging pump 28 draws seawater from outboard of the pressure  
4    hull through the sea valve 30 and flows the seawater through the  
5    open check valve 36 to fill and pressurize the impulse tank 20,  
6    the inlet cylinder 18, and the ejection tank 10, expanding the  
7    elastomeric wall 12 of the ejection tank 10 (FIG. 1).

8        Upon pressurizing the system to a launch pressure, the  
9    charging pump 28 shuts down, as does the sea valve 30, and the  
10   check valve 36 is caused by the launch pressure to shut. At this  
11   point the system is precharged for a launch.

12        Turning to FIG. 3, it will be seen that the check valve 36  
13   includes a housing 44 supporting a valve seat portion 40 provided  
14   with a flow-through orifice 42. The valve seat portion 40 is  
15   adapted to receive a valve head 46 to close off flow through the  
16   valve. The valve head 46 is fixed at an end of a valve stem 48.  
17   The orifice 42 is disposed in the direction, flow-wise, of the  
18   charging pump 28.

19        Fixed in the valve housing 44 is an annularly shaped metal  
20   cup 50 provided with a circular depression 52 (FIG. 4). The cup  
21   50 is held in a stationary manner within the housing 44 by at  
22   least one, and preferably a plurality, of struts 54 (one shown in  
23   FIGS. 3 and 4). The valve stem 48 is reciprocally moveable  
24   through the center of the cup 50.

1        The circular depression 52 is, at its bottom end portion 56,  
2        of a substantially V-shaped configuration in cross-section, as  
3        shown in FIG. 4. Extending radially outwardly from the circular  
4        depression bottom end portion 56 are holes 58 which extend to an  
5        outer wall 60 of the cup 50.

6        A coil spring 62 is mounted on the valve stem 48 and extends  
7        between the cup 50 and the valve head 46. The spring urges the  
8        valve head 46 toward the valve seat portion 40 to close off flow  
9        through the valve. However, the spring force is readily overcome  
10      by the flow of incoming seawater when the charging pump 28 is in  
11      operation.

12      The valve stem 48 has fixed thereon a curricular metal disk  
13      64 having an annularly-shaped protrusion 66 facing the circular  
14      depression 52. The protrusion 66 in cross-section (FIG. 4) is  
15      shaped complementarily to the depression 52.

16      Inasmuch as the disk 64 is fixed to the valve stem 48, which  
17      is reciprocably moveable through the cup 50, and the cup 50 is  
18      held stationary, the disk protrusion 66 is moveable into and out  
19      of the depression 52 as the valve 36 operates.

20      In preparation for a launch, an appropriate launch tube door  
21      32 is opened to place the torpedo 24 in communication with the  
22      outboard seawater through a shutterway 34 (FIG. 1). The charging  
23      pump sea valve 30 is opened and the pump 28 pushes incoming  
24      seawater against the valve head 46 of the check valve 36, forcing

1 the valve head to move against the spring 62 to open the valve  
2 orifice 42.

3 The seawater is then pumped into the impulse tank 20, inlet  
4 cylinder 18, and ejection tank 10, causing the elastomeric wall  
5 12 to expand.

6 When pressure in the ejection tank 10, impulse tank 20, and  
7 inlet cylinder 18 reaches launch pressure, the pump 28 shuts off  
8 and such launch pressure, in combination with the spring 62,  
9 moves the valve head 46 rapidly toward the valve seat portion 40  
10 to close the valve 36.

11 During the rapid closure of valve 36, the disk protrusion 66  
12 enters the cup depression 52. As the cross-section of the  
13 depression decreases, the water therein can remove itself from  
14 the incoming protrusion 66 only by squeezing through either the  
15 primary path of a decreasing annular gap between the disk  
16 protrusion 66 and cup depression 52 or through the secondary path  
17 of the holes 58. The exiting water cannot get out of the way of  
18 the protrusion 66 instantly, but rather has to exit through the  
19 flow restrictive annular gap and holes. Thus, at the last  
20 instant, the movement of the disk 64, and therefore the valve  
21 stem 48, and therefore the valve head 46, is slowed into a  
22 relatively gradual and "soft" engagement of the valve head 46  
23 with the valve seat position 40. The noise generated by the  
24 impact of the valve head and valve seat portion is, accordingly,  
25 greatly reduced. Furthermore, the movement of the disk 64 at the

1 last instant allows a rapid closure of the valve 36 in that the  
2 pre-movement of the valve head 46 prior to impact with the valve  
3 seat portion 40 effectively restricts flow through the valve.

4 To effect launch, a slide valve, such as 26b is opened (FIG.  
5 1), permitting the pressurized water to enter the torpedo tube  
6 22b to effect launch of a body 24, as shown in FIG. 2. As the  
7 pressure in the launch system starts to subside, the elastomeric  
8 wall 12 deflates. After launch, the slide valve 22b closes, to  
9 set the stage for another cycle of operation.

10 There is thus provided an elastomeric ejection system in  
11 which the check valve operates at a sound level virtually  
12 undetectable by other vessels.

13 It will be understood that many additional changes in the  
14 details, materials, steps and arrangement of parts, which have  
15 been herein described and illustrated in order to explain the  
16 nature of the invention, may be made by those skilled in the art  
17 within the principles and scope of the invention as expressed in  
18 the appended claims.